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THE EFFECT OF BALANCE TRAINING ON POSTURE SWAY IN MULTIPLE SCLEROSIS PATIENTS

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Abstract:

Purpose: The multiple sclerosis disease is one of the most common progressive neurological diseases in young adults. According to this matter, that risk possibility is two or three times more than healthy people. The purpose of current study is to survey the effect of balance training on posture sway in multiple sclerosis patients

Study method: The current study is semi-experimental. In this regard, 20 patients with multiple sclerosis from MS Society of Iran with age range of ($41/85^{\pm}12/59$) and scale score of disability progression (0-5) were participated in this study during 10 weeks (three times a week and Each session 1.5 hour). The posture sway in subjects were measured before and after practicing with static stabilometer machine, and also the paired sample t test with ($P\leq0.05$) for results comparison was used.

Results: The results of research showed that the effect of balance training on general fluctuations decrement (P= 0.000), anterior - posterior (P=0.02) and sway speed range (P=0.01) was meaningful but the exercises effect on medio-lateral sway (P=0.07) was meaningful.

Conclusion: The achieved results from the study showed that the selected balance training was effective on general posture sway especially anterior–posterior.

Keywords: multiple sclerosis, static balance, balance exercises, stature fluctuations

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1. Introduction

The multiple sclerosis disease (MS) is one of the common diseases of central nervous system that is created due to the effect of white blood cells attack to the sheath of the central nervous system which is called myelin (1). The amount of MS infection in women is two or three times more men and infecting age range is between 15-50 years old that its peak is in 30 years (1, 2, and 3). The prevalence amounts of this disease in the world are 150 persons in each 100000 persons that vary depending on country and region (4, 5). The MS disease has various symptoms such as lack of balance, tiredness, and blurred vision, numbness of hands and feet and muscle spasms that among the mentioned symptoms, lack of balance is the most common sign of this disease, so that 78 percent of women and 62 percent of men know the lack of balance as most challenging sign of this disease that is considered as the first factor of walking and stumbling disorder in these persons (6). Balance is the capability of keeping the body position on the reliance surface. During the static and dynamic balance, the body position is controlled by mass center displacement and the start of appropriate responds for returning the body to a stable position, a process which plays an important role in visual, sensory - somatic, vestibular, skeletal system and muscular senses. The body's center of gravity is shifted continuously even while standing consistent (5). The fine and delicate vibrational motions that are used during the study of misbalancing amount at a point in time are called stature fluctuations (6). Coaches often assess the stability of people by the practical rated tests. Although this type of tests can provide the primary information regarding to the performance of balance system, but most of the required parameters for balance sensing are not measured. The body position in experimental situation is evaluated by recording the momentary involuntary movements of the body that are not visible with the eye. This act is conducted by standing on a force plate that measures the vertical forces resulted from body weight based on the calculation of changes in center of pressure over the time on a horizontal plane at different points (7). Balance has reverse relationship with the level of stature fluctuations; means as the person balance is higher, his/her stature fluctuations will be lower and vise-versa (8). Controlling balance requires perception and act; perception includes the integration of sensory information in order to evaluate the position and body movement in space and act and ability to produce force for controlling the situation of body systems that require a complex cooperation between muscular, skeleton and neural systems that are the neural elements for controlling body consist of movement and sensory processes such as vision, vestibular sensory - somatic systems and cognitive and neural processes of the nervous higher level (9).

As it was mentioned, the appropriate balance requires complete correlation between visual, sensory - somatic, vestibular, skeletal system and muscular data of stature

maintainer which all these involved systems in balance got distorted in patients with MS (10). The myelin sheath damage in patients with MS lead to a decrement in sensory - figure information transmission from the brain to the muscles which it cause a disorder in MS patients (11, 12). Generally, the studies have shown that almost 75 percent of patients experience balance disorder during the disease (13, 14). Therefore, keeping the balance in static and stable position is one of the highlight problems in patients with MS and they essentially need appropriate balance for daily activities (15). One of the results of balance disorder in MS patients is sequentially fallings (17, 18). These fallings may lead to physical damage occurrence such as bruising, broken bones, and even trauma injuries like loss of confidence in doing different things (16, 18). Also weak balance and sequential fallings create fear itself and affect the patient's life quality (15), and finally, these disorders lead to dependence increment to others in patients for conducting and doing the daily activities and also a decrement in social communications and feeling of controlling ability on personal life of patients (10). One of the common strategies for optimizing the balance and MS people mobility is using practical programs that some studies in this regard about the effect of balance exercises on MS patients' balance were conducted.

Cattaneo et al (10) survey the effects of balance exercises on MS patients. The results of this research show that rehabilitation balance is an appropriate tool to reduce falls and improve balance skills in people with MS. Also, practicing in different sensory fields leads to an optimization in dynamic balance. Kasser et al (18) surveyed the effect of balance exercises on MS patients. In this study, the Pro balance master device for practicing and measuring was used. The results showed 10 to 64 percent optimization in special measures of dynamic balance using limits of stability tests. Also, the results showed a meaningful increment in sensory organs performance by balance exercises using sensory organization test in 2 persons from 4 persons. Jackson et al (19) surveyed the effect of balance exercises on MS patients in 14 samples during 6 weeks of balance exercises and then, they were evaluated using Berg, Smart and Balance master stability test. The achieved results showed that balance programs lead to an optimization of balance in MS people with average disability level. Hilfiker et al (20) introduced the dynamic balance as a sensitive index for assessing rehabilitation and avoiding from falling risk in MS patients. In this study, 18 MS patients were presented with EDSS (expand disability state scale) lower than 5. The used test in this study was test of walking for 3 minutes which for balance assessment, 3D accelerometer was used. The achieved results from this study showed the positive effect but low on the static balance (0.3) dynamic balance optimization (0.6) and movement speed optimization (0.6). Forsberg et al (21) assessed the effect of balance exercises using monitoring games on MS patients. This study which lasted for 6 weeks didn't show a meaningful (significance) difference between two experimental groups. Sosnoff et al (22) surveyed the effect of home workout programs on MS patients and their

falling risk decrement. The aim of this study was to determine the possibility of having a safe and effective home exercises to reduce the risk of falling in elderly patients with multiple sclerosis. For balance evaluation, Berg scale was used. The achieved results of this study showed that balance exercises in home can lead to a decrement of falling risk in MS patients. Berichetto et al (23) surveyed the effect of monitoring games on patients with MS.

The aim of this study was to evaluate the effect of visual feedback exercises improve balance in MS patients. The achieved results with the use of Berg scale and registration the area with open and closed eyes fluctuations showed that the effect of balance exercises was meaningful using monitoring games on the MS patients' balance. Yazdani et al (24) surveyed the effect of one period treatment exercise on the balance of persons with MS; and reached the conclusion that treatment exercise is effective in balance optimization of men with MS. The most researches in this field showed that people with MS have lower balance than ordinary people and in this regard, according to the complications and problems resulted MS disease in patients, the evaluation of balance for those that are infected by MS in order to early detection of problems with balance and also surveying the effect of interventions for curing this problem and patients with MS seems essential (25). Also, the most conducted researches in this field showed that sporting exercises can have positive effects on balance performance of people with MS but regarding to this matter that some ambiguities obtained from the achieved results, instruments used for balance measuring, employed exercises, time devoted to exercise and lack of research on stature fluctuations in MS patients and also considering that previous research had not studied the precise front - back and left and right figure fluctuations, , speed and general fluctuations; the purpose of current study is to survey the effect of balance exercises on static balance in MS patients to be determined that can the presence of physiotherapy sessions and balance exercises have effect on stature fluctuations in patients?

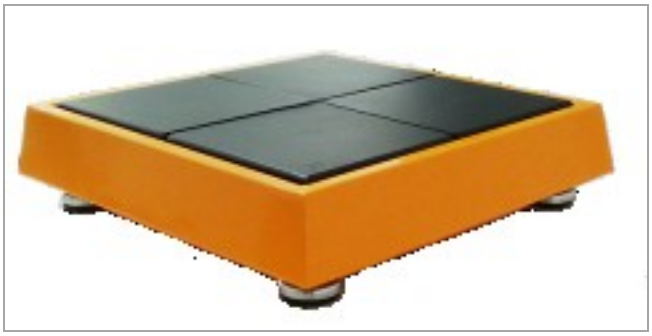
2. Survey method

The current study is semi-experimental that is measured the effect of independent variable (balance training) on dependent variable (static balance) conducting pretest and post-test. The statistic society of current study was patients with MS in Tehran that based on the conducted studies; the statistical society was consisted of 20 persons (15 women and 5 men) of patients with multiple sclerosis from MS Society of Iran with average age ($41.85^{\pm}12.59$) that their disease was confirmed by physician neurologist with clinical examination and MRI. All patients participated voluntary and with a written consent in the study. All samples before entering to the research had history of 6 months participation in physiotherapy exercises (regularly 2 times a week). The entrance criterions

to the study were passing at least 4 years of diagnosis, passing at least 3 months after of disease recurrence, having a secondary progressive disease, having the scale of progression of disability (EDSS) less than or equal to 4.5 to be able to stand and walk without assistive devices and devoid of any vision, hearing, or disorder of skeletal fractures. The exclusion criteria from the study were any attacks and relapses during 10 weeks of training, balance, medication changes, any physical damage and participate in training sessions (over 2 sessions) of Physiotherapy.

The survey instrument is included of a static stabilometer of Danesh Salar Iranian Construction Company with a personal computer (laptop). The validity of the device compared with Kistler force plates at a significance level less than ($p<0.001$) is reported 0.84 by the manufacturer and the internal consistency of the subjects and between subjects at a significance level less than ($p<0.001$) is reported 0.89 by the manufacturer. Device Detector static balance analyzes the postural fluctuations and indirectly based on the reaction of the static level of the forces caused by changes in a person's center of gravity measurements. All of information from the body are used for a moment and visualization for different parameters for two-dimensional and while standing with eyes open and close. The device has 40*40 size which has four sensor in four axes of device that show the level of forward, backward, left and right fluctuations with percentage and cm. Also, this device in the first part shows the center of gravity stability of sample in the range of 5 to 100 as percentage and in other parts, it shows the standard deviation from equilibrium, the standard deviation from equilibrium, the balance in percentage terms, the balance in percentage terms, the point of balance in terms of centimeters, width equilibrium in cm of the center of gravity at the top left. percent of the center of gravity in the lower left of the center of gravity at the top right of the center of gravity at the bottom right, the standard deviation to the left of the point of balance, the standard deviation to the right of the point of balance, the maximum deviation of the left, the maximum deviation to the right, back and forth the standard deviation of the equilibrium point, the maximum deviation F forward, backward maximum deviation and total area Handling.

Image 1: Overview of static stabilometer machine



The used exercises in this research were balance exercises that MS patients could easily do individually or with the help of a family member. The training for 10 weeks, 3 sessions per week and each session was 5.1 hours environmental physical therapy. Everyone has to start balance training for 10 minutes of static stretching exercises to do. Because exercise exhaustion for MS patients is harmful, the rest time was more than the duration of the exercise. To pre-test before starting the training, each person was standing barefoot on the balance detector while kept hanging placing their hands beside her body and without having to speak for 10 seconds looked at paper was installed on the wall in proportion to her height. The person was tested 3 times to increase reliability and best performance was recorded for each patient. Then, patients studied for ten weeks to balance training and after ten weeks of training, balance, pre-test and post-test as well as the conditions of the subjects were taken, and points per person based on scores obtained from the pretest and posttest about the deviation to the front-back, left and right and postural sway velocity of the center of pressure (COP) was analyzed and compared using correlative t statistical test ($P< 0.05$) and also using SPSS software. The exercises used in the study are as follows:

Table 1: Exercise protocol

Movement type	**Movement time**	**Rest time**	**Set × Time**
Angle Move	15 seconds for each leg	One minute	15 × 6
Bending the knee at 90 degrees with chair	15 seconds for each leg	One minute	15 × 6
Bending the hip at 90 degrees with chair	15 seconds for each leg	One minute	15 × 6
Opening the foot to the backward with chair	10 seconds for each leg	One minute	10 × 8
Standing on the toe and heel of the foot	15 seconds for each move	One minute	15 × 8
Putting hands on the waist and Putting the palm of one foot on the other knee and Going up on the claws (stork move)	15 seconds for each leg	One minute	15 × 6
Keeping the body at a low level by putting the hands in front of the body	10 seconds	One minute	10 × 6
Distancing the hip from body	10 seconds for each leg	One minute	10 × 6
The common bending of hip against the wall	15 seconds	One minute	15 × 8

3. Results

The results of balance training on MS patients using the paired sample t-test are as follows:

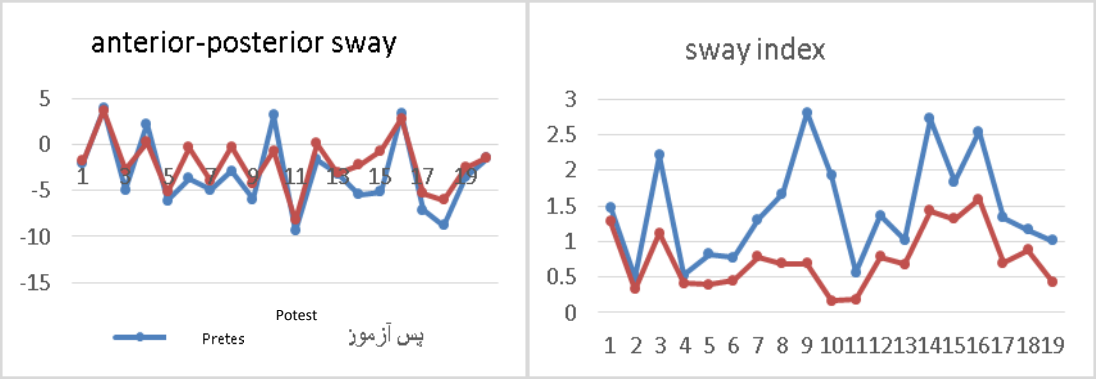
Table 2: The results of t correlative test (Pre-test- Su-test comparison)

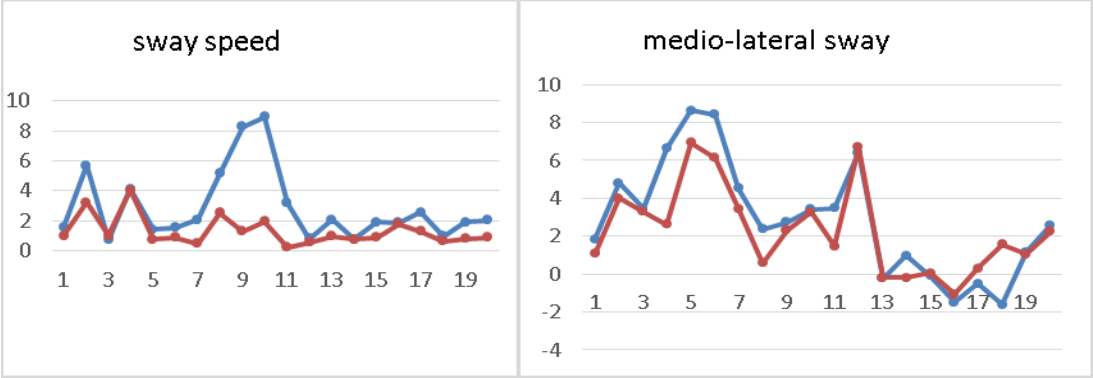
	Mean	Standard deviation	T	Sig level
Sway index	0.66	0.54	5.46	0.000
Sway to anterior – posterior	1.08	1.93	-2.51	0.02
Sway to medio – lateral	0.60	1.44	1.86	0.07
Sway speed (rate)	1.58	2.05	3.45	0.01

According to the obtained scores in table 2, the sway index of posture was gotten meaningful with achieved t 5.46 (p≤ 0/05), anterior–posterior fluctuate Index with achieved t -2.51 (p≤ 0/05), range of stature sway speed with achieved t 3.45 (p≤ 0/05). But the medio–lateral sway Index was not gotten meaningful with achieved t 1.86 (p≤ 0/05) according to the scores between pre-test and post-test.

Table 3: The comparison of posture sway rates before and after balance training

	Pretest	Su-test	Changes percent
sway index percent	5.18	3.47	33%
The length of balance point on X axis (cm)	2.37	3.18	16%
The width of balance point on X axis (cm)	-2.91	1.54	48%
Presence Percentage of the center of gravity to the left toe	27.38	22.70	10%
Presence Percentage of the center of gravity to the left heel	13.22	11.90	13%
Presence Percentage of the center of gravity to the right toe	25.25	28.27	40%
Presence Percentage of the center of gravity to the right heel	34.15	37.13	16%
The level of fluctuations to the medio - leteral (cm)	2.84	2.39	16%
The level of sway to the anterior and posterior (cm)	-1.82	1.33	27%
The average of sway speed to the left and right (cm per second)	2.48	2.86	10%
The average of sway speed to the anterior and posterior (cm per second)	2.45	1.82	19%
Range of displacement on x and y axes	0.58 (cm^2)	0.46	11%

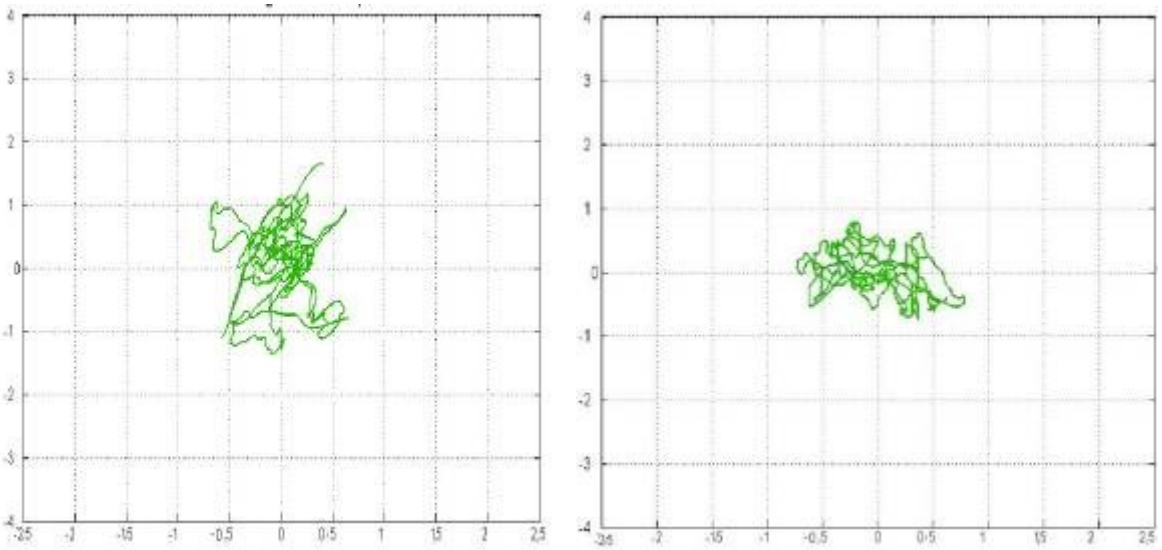




4. Discussion

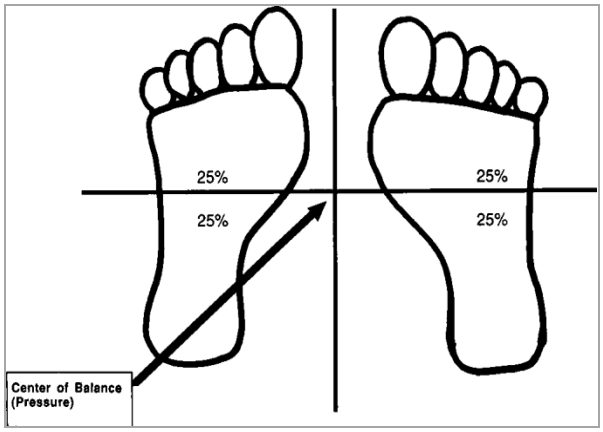
The balance disorders is one of the common and primary symptoms of the disease multiple sclerosis. Several studies studied the balance disorders in MS patients that their results show that more than half of people with MS, even those with normal clinical testing are impaired balance (3, 26). The aim of the study was to investigate the effect of balance training in MS patients. The findings of this study showed that there is a significant difference between average record pre-test and post-test postural sway, volatility stature to pull back and swing speed sway in MS patients. The achieved results of the study showed 33 percent decrement in sway index, 27 percent decrement in the anterior - posterior sway, 19 percent decrement in average speed of anterior-posterior sway and 11 percent decrement in the range of center of pressure displacement which show the effect of exercises on postural sway; means balance training significantly reduced the postural sway in MS patients.

Image 2: The COP path before balance exercises (image B) in a same sample shows the vertical the anterior - posterior axis fluctuations and horizontal left and right axis sway



According to the physiological adaptation is appropriate in learning the skills, functional training can reduce the variability in the use of motor units, increase the plasticity of the motor cortex or help learning to use those muscles to perform work assignments (27, 28 and 29). Recent results have shown that motor skills training is closely related to the increased excitability of the spinal cortex. It seems neural adaptations by practicing for long term stays, which reflects the importance of exercise features (30). Naturally the center balance point is between the legs, chest and soles of each leg point where 25 percent of body weight can be tolerated (31).

Image 3: Display the placement center of press between the legs



According to the results obtained from exercises, the pressure on the paw was 27.38 percent, 13.22 percent left heel, right paw 25/25 percent and 24.15 percent in the heel of the right foot that this reflects the pressure on the right foot when it was static balance But after doing balance exercises pressure on different parts of the foot and the left foot toe pressure was 22.70 percent and 11.90 in the left heel that was decreased 4.68 percent and 1.32 percent in compared to the previous workouts, respectively. The amount of pressure on the heel of the right foot after doing balance exercises was 37.13 percent and 28.27 percent for right paw that was respectively decreased 3.02 and 2.98 percent. This reflects a further increase pressure on the right foot after balance exercises.

The results of this study showed that this effect is probably created before exercises to optimize the body and lower organs that are resulted from conducting the weight displacement exercises in static statues (20). Another possible reason to optimize the subsequent balance exercises can know the Mega-noorseptor feedback changing that leads to the re-organize the central neural system and movement- sensor unity and also leads to changing in movement respond (32). Also, we can refer to the activation of deep emotion receivers; prepare of motor neurons in the group of muscles and joints to conduct movement; increase the coordination and integration of motor units and contraction of agreed muscles and also increase the inhibition of disagreed muscles (33). But the achieved

results did not show a meaningful difference from amplitude of oscillations to the left and right, and this shows that balance exercises could not meaningfully and significantly lead to the decrement of stature fluctuations in patients with MS. According to this matter, there is a connection between the remover (abductors) muscle weakness of thigh with balance and falling risk. One of the probable reasons of lack of decrement of stature fluctuations to the both sides can be thigh abductor muscle weakness (34). Regarding that thigh reinforcement exercises were included in the program, but more exercises for thigh abductor reinforcement are required for future studies. Also, another probable reason is the absence of sufficient balance exercises that can be effective in lack of meaningfulness in balance exercises on stature fluctuations to the both sides. Because the most utilized balance exercises was in the range of general fluctuations and anterior – posterior fluctuations.

The stature fluctuations to the left and right are the result of lateral movement of the hips although most of fallings occur due to the effect of unexpected disorders creation in balance and also left and right fluctuations (35). The balance exercise can lead to the left and right stature fluctuations decrement (36). Therefore, according to the matter that the utilized disorder exercises were not sufficient in the research, it's suggested for the future researches that balance exercises to the left and right to be used more in exercise programs. This results show the effect of balance exercises on stature fluctuations decrement in patients with MS which its result is optimizing their static balances. Generally, it seems that exercise programs in this research were led to an optimization the samples balance properties and has more advantages than other programs that we can refer to: 1. the principle of specificity of training that refers to the specific aspects of balance maintenance in imbalance conditions which are like compensatory reactions; 2. Creating imbalance which causes challenges in controlling the balance in different directions; 3. Strengthening leg muscles with balance exercises; 4. Using the optimal sensory receptors that provide information about location and organ action for the brain causing the movement without paying attention and more economically (36). The power and sensory receptors are involved effectively in the acquisition balance (15, 37). But in MS Patients, all involved factors get hurt in balance, respectively (10, 17 and 18). Therefore, the exercise can lead to the reinforcement of effective factors in achieving balance (10). The results of this study are in alignment and consonant with the results of Kaser (18), Cattaneo et al (10), Jackson et al (19), Hilfiger et al (20), Jacob et al (22), Brichtu et al (23) and Yazdani et al (24) studies. But it was not consonant with Forsberg et al (21) results. The lack of alignment can be attributed to the method and duration of exercise. As no study was found in the regard of balance exercises effect on optimizing the stature fluctuations in MS patients, there wasn't the possibility of comparison analysis with conducted variables. In order to restore the balance and avoid of falling, there should be coordination between visual, vestibular,

sensory and figurative systems and motor integration system (35). It seems that patients with MS have problem in keeping the body mass in the related stable restriction while performing the movement tasks. Perhaps this could be due to nervous- Central system disorder as well as creating disorder in feed-forward control, in interpretation of sensor data and controlling feed-forward and as a result in can make disorders in choosing the right moving map and moving Map adjusted according to changing internal and external environments, and this matter itself can lead to the disruption of the proper sequence of muscle and body parts relative to each other to be connected (25). But balance exercises can lead to the more neural-muscular coordination in MS patients by challenging the involved systems in balance (38). Therefore, when the patient for example conducts the angle move in order to control the movement of the body's center of gravity must animate his hands and feet to adjust his moves.

The results of study showed that balance exercises as a simple and without complication method were led to the stature fluctuations decrement and decrement in fluctuations range to the front and back and speed range decrement of stature fluctuations in MS patients which its result was the static balance of patients. So, it's recommended that all therapists that are associated with MS use these exercises in the designing part of the exercise for optimizing the MS patients' balance in home and physiotherapy environment.

5. Research restrictions

Indexes of height and weight are crucial and determinant factors in achieving balance, therefore notifying a control group that is against the experimental group in the terms of height, weight and EDSS rate and without exercise for 10 weeks was impractical so because if this reason, the current study was conducted by one group.

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